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GLOBAL MONITORING OF AGRICULTURAL PRODUCTIVITY WITH SPACEBORNE MEASUREMENTS OF SUN-INDUCED CHLOROPHYLL FLUORESCENCE

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ABSTRACT:

Global food and biofuel production are of paramount societal importance. However, model based estimates of gross primary production (GPP, output from photosynthesis) are highly uncertain, in particular over heavily managed agricultural areas. In this study we investigate the potential of space-based retrievals of sun-induced chlorophyll fluorescence (SIF), an emission intrinsically linked to photosynthesis, to provide a direct, global and time-resolved measure of the GPP of cropland and grassland ecosystems.

The following data streams have been used in this analysis: (1) global SIF retrievals from measurements of the MetOp-A / GOME-2 instrument in the 2007-2011 time period; (2) runs from ensembles of process-based and data-driven biogeochemistry models; (3) flux tower-based GPP estimates covering the 2007-2011 time period have been extracted for 17 cropland and grassland sites in the Midwest US and Western Europe; (4) reflectance-based vegetation indices from MODIS and MERIS.

The strong linear correlation between the SIF space retrievals and the flux tower-based GPP, found to be substantially higher than for vegetation indices, has enabled the direct upscaling of SIF to cropland GPP maps at the synoptic scale. Our SIF-based annual crop GPP estimates are 50 to 75% higher than results from state-of-the-art carbon cycle models over the US Corn Belt and the Indo-Gangetic Plain, implying that current models severely underestimate the role of management. This finding is supported by an independent validation against agricultural inventories derived from yield statistics. In addition, we show that generic process-based models fail to capture the seasonality of agricultural areas when the lifetime of the crops differs from that of the natural vegetation in the surroundings.

Ref: Guanter et al., Global and time-resolved monitoring of crop photosynthesis with chlorophyll fluorescence, Proceedings of the National Academy of Sciences, 11, E1327-E1333, 2014.